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ABSTRACT

In light of current research and evaluation criteria, the Gallup Evaluation Model (GEM I and GEM II) was developed and tested at Pennsylvania State University to assess effectiveness and efficiency of instructional developments. Alternative ways of teaching German I were evaluated according to five variables: amount of pupil time, course costs, number of students, student achievement and attitude. A cost-effectiveness analysis compared student achievement and attitude scores to costs of each alternative instructional method. The Pennsylvania study concluded that the model is practical, readily applicable, and workable for deciding which program to eliminate or revise. It is also useful in predicting changes in effectiveness during course recycling and when reworking certain specific variables. (SK)

THE DEVELOPMENT AND IMPLEMENTATION OF A MODEL FOR COMPARING INSTRUCTIONAL ALTERNATIVES

A PAPER PRESENTED
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INTRODUCTION

In the past several years education has seen many rapid changes. Innovations in instruction have flourished. Many of these innovations have been widely adopted. One such innovation is the application of a systematic approach to instruction incorporating the use of mediated instructional materials. The primary purpose of this innovation has been to enable the most efficient and effective instructional methods to be utilized in the classroom. The overall goal of this instructional practice has been to provide instruction to larger numbers of students, in less time and at a lower cost, while at the same time providing a higher quality of instruction.

Within the last several years, instructional development projects and many specific, step-by-step models for the process of instructional development have been devised. Table 1 lists some of these early instructional development models, their authors, and dates of development.

Table 1. Instructional Development Models. (Twelker, Urbach, Buck, 1972)

	Title	Author	Date
1.	Teaching Research System	Hamreus	1968
2.	Michigan State University Instructional Systems Development Model	Barson	1967
3.	System Approach for Education (SAFE)	Corrigan	1966
4.	Project MINERVA Instructional System Design	Tracey	1967
5.	Banathy Instructional Development System	Banathy	1968

Recently in 1972 the Pennsylvania State University initiated a "Program for the Improvement of Instruction" which supported innovative redevelopment of basic courses that served students at several campus locations. The Program funded selected courses for instructional development over the time span of one year. The intent was to improve both instructional effectiveness and cost efficiency. However, the question had been raised, as a result of the investment of time, money and materials in the instructional development of a course, was instruction more effective and/or efficient?

The University Division of Instructional Services at the Pennsylvania State University, which became involved in the production aspect of the Program for the Improvement of Instruction, had several criteria to evaluate outcomes of the redeveloped courses. These criteria as listed by Greenhill (1972) were:

CRITERIA FOR EVALUATION OF OUTCOMES

Cost/benefits

1. Same cost but improved quality - (e.g., fewer drop outs, improved learner competencies, improved attitudes toward course).
2. Handle more students at same cost.
3. Cover more material (which is learned) in same time.
4. Cover same amount of material in less time.
5. Make more efficient use of space.
6. Have students with lower or more varied input competencies reach desired level of performance.

While the criteria for the evaluation of a course selected for instructional development were specific and detailed, no method was

provided for combining these factors into an organized procedure for assessment and decision making. It seemed as though some procedure would be useful in making an objective, quantitative evaluation of the outcomes of a redeveloped course.

Statement of the Problem

As a result of the systematic approach, i.e., instructional development being utilized with increased regularity to design instructional strategies, some procedure is required to determine the overall combined impact of all of the instructional variables such as those Greenhill lists as criteria to evaluate the outcomes of redeveloped courses. This procedure would provide information necessary in the evaluation of the instructional process and assist in deciding whether to revise or not revise a course of instruction. Further, this procedure would help answer the questions: Is the product of instructional development effective? Does it contribute to improved learning? If so, how much? If not, why?

Purpose of the Study

The purpose of this study was to develop and implement a model which could be used in the evaluation process for comparing instructional methods. The model attempted to determine the relative effectiveness of two different methods or alternatives of teaching the same course content. The first method of instruction was defined as the established or traditional instructional process. The second method was defined as any set of educational strategies which were developed by following an organized sequence of course development, i.e., an instructional development process. For this study, efficiency and effectiveness

of a course were defined as a function of the following variables: (1) student achievement, (2) student attitude, (3) number of students in a course, (4) cost of offering a course, and, (5) amount of time students spend in course instruction.

The development of a model such as the one proposed in this study had been recognized as a fruitful area for consideration by instructional developers concerned with the need to optimize instructional methods and evaluate the results of instructional development. Davies (1971) stated, "In view of the increasing investment now being made in educational and training systems, some form of responsible audit or evaluation is becoming more and more necessary." It seemed that some method of determining efficiency and effectiveness was becoming more and more necessary to make decisions about different instructional methods.

REVIEW OF THE LITERATURE

A survey of the literature revealed that an adequate evaluation model has been sought by educators for some time. A collection of models, flowcharts, and diagrams have emerged to answer this demand, i.e., Alkin (1969), Stufflebeam (1967), Klein (1972), Stake (1967) and Greenhill (1972). However, few of these models have taken into account all the factors necessary in assessing practical improvement in a course as a function of change in method of instruction. Research which involved the formative evaluation of an instructional development process was also limited and provided further impetus for this study.

No studies were located which compared a method of instruction resulting from an instructional development process with another form of teaching strategy development. However, many articles, reports, and books have been written concerning the instructional development process, including

books by: Lee (1971), Kemp (1971), Gustafson (1973), Banathy (1968), Crawford (1969), and Diamond (1971).

MODEL DESIGN AND IMPLEMENTATION

INTRODUCTION

A theoretical model developed by Stephen Klein (1972) was located which had potential for use in the formative evaluation of two methods of teaching the same course content. However, several modifications were necessary to make this theoretical model practical and workable as an instrument in the formative evaluation process.

Based on Klein's work, two new models for evaluating and comparing instructional programs were developed. Hereafter, these two models will be referred to as the Gallup Evaluation Model I (GEM Model I) and the Gallup Evaluation Model II (GEM Model II). One of these models assesses course effectiveness on an achievement basis (GEM Model I) while the other models take into consideration the interaction between most of the variables listed by Greenhill (1972) as criteria to evaluate the outcomes of redeveloped courses.

The GEM Model I: Achievement Basis

In determining course effectiveness on an achievement basis, Total Course Effectiveness may be represented by E_1. Effectiveness of one instructional method (Alternative I) may be represented by e_1. The other instructional method's effectiveness (Alternative II) as e_2. Total Course Effectiveness (E_1) = Effectiveness of Alternative I (e_1) + Effectiveness of Alternative II (e_2). The effectiveness of an alternative (e_1 or e_2) may be viewed as the achievement gained in al alternative multiplied by the number of students enrolled in an alternative,

divided by the product of the time students devoted to instruction multiplied by the costs of offering an alternative or:

$$e_i = \frac{(A)}{(T)} \times \frac{(S)}{(C)}$$

The development of the model may be understood more clearly by examining information in Figure 1. Assuming a course is made up to two sections, and each section is taught by a different alternative method of instruction, a measure of effectiveness for each alternative may be determined, as described above. Then, a percentage of Total Course Effectiveness (E_1) can be calculated for each section:

$$E_1 = e_1 + e_2$$

$$\text{Relative effectiveness of Alternative I} = \frac{e_1}{E_1} \times 100$$

$$\text{Relative effectiveness of Alternative II} = \frac{e_2}{E_1} \times 100$$

Once a percentage of relative effectiveness is calculated for each alternative, a decision may be reached concerning which alternative method of instruction should be implemented, which method should be eliminated and/or which method should undergo revision.

For the purposes of this model the following variables are used in determining relative effectiveness on an achievement basis:

Amount of Pupil Time. The amount of time is determined by the amount of time students devote to a course, both in and out of class, i.e., direct instruction time, textbook or supplemental reading time, laboratory time, library time, writing time, time spent in studying for quizzes and examinations, as well as the time involved in taking quizzes and examinations. For the purposes of GEM Model I, time students devote

Figure 1. GEM Model I; Achievement Basis

Total Course Effectiveness (E_1) = Effectiveness of Alternative I (e_1) + Effectiveness of Alternative II (e_2)

$$e_1 = \text{Achievement per Time per Cost per Student}$$

$$= \frac{\text{Achievement per Time}}{\text{Cost per Student}}$$

$$= \frac{\frac{\text{Achievement}}{\text{Time}}}{\frac{\text{Cost}}{\text{Number of Students}}}$$

$$= \frac{\text{Achievement}(A_1)}{\text{Time}(T_1)} \div \frac{\text{Cost}(C_1)}{\text{No. of Students}(S_1)}$$

$$= \frac{(A_1)}{(T_1)} \div \frac{(C_1)}{(S_1)}$$

$$= \frac{(A_1) \times (S_1)}{(T_1) \times (C_1)}$$

$$e_2 = \text{Achievement per Time per Cost per Student}$$

$$= \frac{\text{Achievement per Time}}{\text{Cost per Student}}$$

$$= \frac{\frac{\text{Achievement}}{\text{Time}}}{\frac{\text{Cost}}{\text{Number of Students}}}$$

$$= \frac{\text{Achievement}(A_2)}{\text{Time}(T_2)} \div \frac{\text{Cost}(C_2)}{\text{No. of Students}(S_2)}$$

$$= \frac{(A_2)}{(T_2)} \div \frac{(C_2)}{(S_2)}$$

$$= \frac{(A_2) \times (S_2)}{(T_2) \times (C_2)}$$

WHERE:

A_1 and A_2 = the total difference between pre- and post- test scores on a standardized achievement test.

T_1 and T_2 = the total amount of time students spend in course instruction, both in and out of class.

C_1 and C_2 = the total operating costs of a method.

S_1 and S_2 = the total number of students completing both pre- and post- standardized achievement tests.

to a course is recorded on a time sheet in hours and minutes on an individual basis.

Costs of Offering a Course. The costs of offering a course includes all those expenses incurred in conducting a course. These costs include, the proportion of faculty and staff salaries devoted to each course, the costs of space in which a course is taught (costs of classroom space including utilities), and the expendable costs such as stencils, reproduction materials and paper. Faculty and staff salary figures are obtained from the specific individuals involved. The cost of classroom space is obtained through University sources. Costs of expendable materials are kept by the instructors on expense forms. Costs of resources utilized by a large majority of a University community are not included. These include such facilities as University libraries, learning centers, and language laboratories.

Number of Students. The number of students is determined by the enrollment within the sections of a course. For purposes of GEM Model I, all students in the treatment sections completing both the pre- and post- tests are considered as the number of students enrolled.

Student Achievement. Student achievement is determined by the administration of a standardized achievement test selected from a source such as the Buros' Mental Measurements Yearbook on the basis of course subject matter. Students in all treatment sections receive this standardized test both before and after instruction. The score used for calculating effectiveness, utilizing GEM Model I, is the gain score difference between pre- and post- tests.

GEM Model II: Attitude Basis

In determining course effectiveness on an attitude basis, Total Course Effectiveness is represented by E_2. Effectiveness of Alternatives I and

II are represented by e_1 and e_2 respectively. Total Course Effectiveness (E_2) = Effectiveness of Alternative I (e_1) + Effectiveness of Alternative II (e_2). The effectiveness of an alternative (e_1 or e_2) may be viewed as the total positive attitude in an alternative multiplied by the number of students enrolled in an alternative, divided by the product of the time students devote to instruction multiplied by the costs of offering an alternative, or:

$$e_1 = \frac{(At) \times (S)}{(T) \times (C)}$$

The development of the model may be understood more clearly by examining information in Figure 2.

Assuming a course is made up of two sections, and each section is taught by a different alternative method of instruction, a measure of effectiveness of each alternative may be determined as described above. Then, a percentage of Total Course Effectiveness (E_1) can be calculated for each section:

$$E_1 = e_1 + e_2$$

Relative effectiveness of Alternative I $= \frac{e_1 \times 100}{E_1}$

Relative effectiveness of Alternative II $= \frac{e_2 \times 100}{E_1}$

Once a percentage of relative effectiveness is calculated for each alternative a decision may be reached concerning which alternative method of instruction should be implemented, which method should be eliminated and/or which method should undergo revision.

For the purposes of this model the variables used in determining effectiveness on an attitude basis are the same as those employed in the

Figure 2. GEM Model II: Attitude Basis

Total Course Effectiveness (E_2) = Effectiveness of Alternative I (e_1) + Effectiveness of Alternative II (e_2)

e_1 = Attitude per Time per Cost per Student

$$= \frac{\text{Attitude per Time}}{\text{Cost per Student}}$$

$$= \frac{\frac{\text{Attitude}}{\text{Time}}}{\frac{\text{Cost}}{\text{Number of Students}}}$$

$$= \frac{\text{Attitude}(At_1)}{\text{Time}(T_1)} \div \frac{\text{Cost}(C_1)}{\text{No. of Students}(S_1)}$$

$$= \frac{(At_1)}{(T_1)} \div \frac{(C_1)}{(S_1)}$$

$$= \frac{(At_1) \times (S_1)}{(T_1) \times (C_1)}$$

e_2 = Attitude per Time per Cost per Student

$$= \frac{\text{Attitude per Time}}{\text{Cost per Student}}$$

$$= \frac{\frac{\text{Attitude}}{\text{Time}}}{\frac{\text{Cost}}{\text{Number of Students}}}$$

$$= \frac{\text{Attitude}(At_2)}{\text{Time}(T_2)} \div \frac{\text{Cost}(C_2)}{\text{No. of Students}(S_2)}$$

$$= \frac{(At_2)}{(T_2)} \div \frac{(C_2)}{(S_2)}$$

$$= \frac{(At_2) \times (S_2)}{(T_2) \times (C_2)}$$

WHERE:

At_1 and At_2 = the total attitude scores on a course attitude survey.

T_1 and T_2 = the total amount of time students spend in a course instruction, both in and out of class.

C_1 and C_2 = the total operating costs of a method.

S_1 and S_2 = the total number of students completing both pre- and post- standardized achievement tests.

determination on an achievement basis with the exception of the achievement variable. The achievement variable is eliminated and replaced by an attitude variable. The value of this variable is the total positive score obtained by students on a standardized course attitude survey administered upon course completion.

MODEL IMPLEMENTATION

The German 1 course at The Pennsylvania State University, undergoing instructional development during the Summer and Fall terms of 1973, was selected for the trial implementation and testing of the developed models in the formative evaluation process. The study sample consisted of college students enrolled in Sections 1, 2, 4, and 5 of German I during the Winter Term, 1973-1974. Alternative I, the on-going, established instructional method was utilized in Sections 4 and 5. Alternative II, a prototype form of instruction resulting from an instructional development process, was employed in Sections 1 and 2. Two instructors each taught two sections of German 1, one section by Alternative I, the other section by Alternative II.

FINDINGS

As a result of this trial implementation of the developed GEM Models in the formative evaluation of two methods of teaching the same course content, the following findings are presented.

It was possible to develop evaluation models which were practical, workable procedures for use in the evaluation of two methods of teaching the same course contents. The two models which were developed both on an achievement and attitude basis brought together factors necessary in assessing course effectiveness and efficiency.

A second finding was the ease with which the developed models could be implemented in the evaluation process. The data for the factors of

number of students, student achievement, and student attitude would normally be gathered in any reliable evaluation of instruction. Costs of offering a course and amount of pupil time are two factors requiring data gathering which may not normally be done in a formative evaluation of course insturction.

When implementing these models as part of the evaluation process, differences in effectiveness and efficiency resulting from two ways of teaching the same course content were detected. In detecting these differences the GEM Models examine the interaction between variables associated with course instruction. These variables, which include Student Achievement and Attitude, Time Spent in Course Instruction, the Costs of Offering Instruction, and the Number of Students enrolled in instruction, make up the criteria Greenhill (1972) listed as necessary to evaluate redeveloped courses. The differences in effectiveness and efficiency which are detected may determine whether a method of instruction is implemented, eliminated, or where revision can be made within a method.

DISCUSSION OF FINDINGS

The GEM Models which were developed for use in evaluation process had a main advantage and a corresponding disadvantage. The advantage of the GEM Models was that they brought together variables which were indicators of course effectiveness and/or efficiency, particularly criteria for evaluation as listed by Greenhill (1972), in a practical, workable procedure for use in the formative evaluation process. The disadvantage occurs because the GEM Models did not examine specific variables alone. If the priority of goal of two methods of teaching the same course content was to improve student achievement, then the GEM Models were at a disadvantage becuase they could not detect a change in a single variable.

To illustrate this disadvantage, the formative evaluation of German 1 on an overall achievement basis is used as an example. Students in

Alternative II gained an average 1.35 points more on the achievement measure than students in Alternative I. However, overall Alternative I reached a higher percentage of relative effectiveness (58.80% vs. 41.19%) primarily because students in Alternative II devoted an average of 16 hours more to course instruction. In this example, the larger amount of time in Alternative II offset a gain in achievement by students in Alternative II, making Alternative I relatively more effective (+17.61% higher). Therefore, it should be kept in mind that while the GEM Models do bring together variables which are indicators of course effectiveness, these same variables should be examined by other evaluation instruments on an individual basis.

The five variables incorporated in the GEM Models each had specific concerns which may need to be taken into consideration when implementing them in the evaluation process. The five variables and a discussion of their specific concerns follow.

Amount of Pupil Time. The amount of time students devoted to a course was viewed as a negative variable (Klein, 1972). One criteria listed by Greenhill (1972) was to cover the same amount of material in less time. Less time devoted to one course allowed students to spend time on other courses or activites. Certain concerns should be kept in mond regarding the amount of pupil time variable incorporated in the developed model. One concern was whether the amount of time recorded by students was accurate. In this study it was assumed that students recorded the actual amount of time they devoted to course instruction.

Costs of Offering a Course. The costs of offering a course was the other negative variable. The main concern associated with this variable was in obtaining all costs incurred by an alternative method of instruction. If all costs were correctly determined, the value of specific expenses

may be used in the redevelopment of a method of instruction to make that method more efficient.

Number of Students. The number of students was viewed as a positive variable. The major concern regarding the number of students is that a method if instruciton enrolls the largest number of students to which it can effectively provide course instruciton. This results in an optimum use of classroom materials and space. A low number of students enrolled in a course results in poor utilization of the costs of offering a course.

Student Achievement and Student Attitude. Student achievement and student attitude were the other two positive variables. The main concern with these variables was that slight gains in them were offset by larger gains in the negative variables of amount of pupil time and costs of offering a course.

It must be kept in mind that the models were not developed to examine specific variables by themselves. Decisions regarding student achievement or attitude made utilizing the models may be misleading and/or biased. The developed GEM Models examine these variables in combination with other variables and put them is a perspective to determine overall course effectiveness and/or efficiency.

CONCLUSIONS

Based on the findings of this study the following conclusions were drawn regarding the GEM Models I and II.

1. The Models are workable procedures for the evaluation of two methods of teaching the same course content. Based on Scriven (1967) the developed models provide a means or evaluating courses in a state of development. Bloom, Hastings, and Madaus (1971) state: "learning is a process which can be observed and evaluated as it takes place." The models

developed in this study observe and evaluate a learning process as it is occurring.

2. The Models are only one instrument in the evaluation process. Based on the data analyzed by the models in this study it would appear at first glance that Alternative II, or the alternative that underwent instructional development, has proved to be less effective than Alternative I. However, in looking at mean achievement and attitude scores (Table 12) which are also indicators of course success, students in Alternative II reached a higher level of achievement (+1.76 points) and at the same time were slightly more favorable toward Alternative II as a method of instruction (+3.77 points). Another source of evaluation may come from people directly involved with the alternatives of instruction--course instructors. Based on the observations made by the instructors of German 1, students in Alternative II had better class attendance (resulting in a larger time variable--+16 hours), participated in class discussion more freely, and seemed to enjoy class more than students in Alternative I (as indicated by a larger attitude variable score--+3.77 points).

3. The Models examine and take into consideration factors of educational effectiveness and efficiency. Utilizing the variables amount of pupil time, costs of offering a course, number of students, student achievement, and student attitude in the evaluation process, a basis may be established for making decisions involving the most efficient and effective method of course instruction.

4. The Models may be used for predicting effectiveness of outcomes during a recycling of the course development process. If a particular alternative of instruction has shown a weakness in one variable during an initial evaluation, course developers can determine the specific change needed to strengthen the identified variable. As an example, in this

study the cost of Alternative II was $84.13 more than Alternative I. If this larger cost is considered a weakness and warrants improvement, reducing the cost variable of Alternative II by $84.13 can be recalculated to predict a new relative effectiveness for each alternative. This prediction ability of the models may help instructional developers identify specific variables which, with reworking, will improve both the effectiveness and efficiency or a method of course instruction.

5. The Models may only be used to interpret those variables which were in existence at that point in time when the formative evaluation occurred. Decisions regarding course recycling or redevelopment should be made based upon model findings and not upon what might have been. In course recycling the models may be used to predict changes in effectiveness and efficiency resulting from reworking specific variables.

6. The Models should only be used when both methods for teaching the same course content have as their overall goal the same basic objectives. When two methods of teaching the same course content have overall goals which are the same, these two models may be used for evaluation. As an example, the overall goals for both alternatives of instruction in this study were to teach students the basic reading, writing, listening, and speaking skills of elementary German. While the instructional methods were different, the overall objectives were the same.

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